

CHITONS TAKEN BY THE UNITED STATES FISHERIES
STEAMER "ALBATROSS" IN THE NORTHWEST PACIFIC
IN 1906.

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A small series of chitons taken in the course of the Northwest Pacific Expedition of the United States Fisheries Steamer *Albatross* during the summer of 1906 was kindly transferred to the writer by Dr. Harold Heath, of Stanford University, for study and report, and forms the subject matter of the present paper. Though rich neither in species nor in individuals, the fact that our knowledge of the chiton fauna of this region is slight and the fortunate circumstance that the specimens were kept in alcohol render the material noteworthy. The collection comprises in all some 45 specimens. These are referable to 11 species, of which the 4 named below are described as new:

Leptochiton diomedea, new species.

Ischnochiton (Lepidozona) amabilis, new species.

Ischnochiton (Lepidozona) interfossa, new species.

Ischnochiton (Lepidozona) pilsbryanus, new species.

Family LEPIDOPLEURIDAE.

Genus LEPTOCHITON Gray 1847.

LEPTOCHITON DIOMEDEAE, new species.

Plate 1, figs. 1-3; plate 2.

Description.—Shell rather small, elliptical, the shell and girdle together approximately twice as long as broad. Insertion plates lacking. Valves moderately elevated, sharply arcuate. Anterior valve with a concave anterior slope due to the apical region rising more abruptly than the slightly flaring marginal region; posterior margin broadly Λ -shaped in outline when the valve lies in its normal position. Median valves with small but sharp and rather prominent beaks, their anterior margins only slightly arcuate except the second

valve, where the tegmentum extends well forward mesially. Tail valve lower and a trifle narrower than the head valve, the flaring margin rendering the posterior slope distinctly concave; central area mildly convex, the anterior margin arcuate; mucro a little in front of the center.

Anterior valve with a sculpture comprising a large number of small, sharp, conical granules of ovate outline, very closely placed with a greater or less quincuncial arrangement, so that there often appear evidences of a secondary ranking of the granules in series oblique to the lines of growth. Intermediate valves with distinct lateral areas, the mesial regions of the latter somewhat sunken, but their anterior margins raised to form a pseudo-rib; finer sculpture of lateral areas very similar to that of the head valve; central areas everywhere except in the immediate vicinity of the beaks covered with a copious fine file-like sculpture of crowded, but distinct and rarely overlapping pustules like those described except that toward the sides they show a quite definite arrangement in longitudinal lines (these lines being roughly continuous with the less definite and more oblique series of the lateral areas in a manner not brought out in the drawing). The posterior valve corresponds in sculpture to the remainder of the shell (pl. 1, fig. 1).

Interior of head valve simple, but quite heavily calloused near the margin. Intermediate valves with sutural laminae well separated, broadly triangular, acute in front, and attached beneath the tegmentum in such a way that the latter projects over somewhat at the base and there is a notch giving a false appearance of slitting at the sides; anterior sinus broad at the base, not quite as wide as the adjoining laminae. Posterior valve with a rather heavy callus at the margin and another supporting the sutural laminae which are shorter and have more rounded margins than those of the intermediate valves (pl. 2, fig. 2).

Girdle with a dorsal armature of small, close-set spines, usually very even in size, but occasionally both at the margin and elsewhere a few scattered dagger-like spines, two or three times the length of the commoner ones, may be noted (pl. 1, fig. 3; pl. 2, fig. 5). With rather frequent exceptions all the spines show an outward trend. No striation can be detected with such magnification as I have been able to use. The spinelets of the ventral surface differ in their close palisading, smaller size, more conical outline, and even greater uniformity for any given region of the girdle (pl. 2, fig. 4).

Radula with large, strongly bidentate second laterals, medians small and mushroom-like in outline, first laterals small. My preparation of the radula did not prove satisfactory and the drawing merely serves to indicate the main features (pl. 2, fig. 6).

Color (in alcohol) a light yellowish brown without mottlings, Interior of valves white.

The ctenidia are posterior in position and number about 12 on each side.

Maximum length of type, 15 mm.; width, 8 mm.

Type.—Cat. No. 215625, U.S.N.M. [S. S. B. 95].

Type-locality.—Station 4967, 244–253 fathoms, brown mud, etc., bottom temperature 45.9° F., off Shio Misaki Light, Japan.

Remarks.—This little species is fairly large for a *Lepidopleurus*, but offers no particularly striking characters. The three recognizable Japanese members of the genus, *L. hakodatensis* Thiele, *L. japonica* Thiele, and *L. assimilis* Thiele, are all from much shallower water and differ entirely in the possession of broad, striated girdle scales little resembling the smooth, narrow spinelets of the present form. The radula of the latter is also distinctive, possibly showing most resemblance to that of *L. hakodatensis* as figured by Thiele.

Family CALLOCHITONIDAE.

Genus TONICELLA Carpenter, 1873.

TONICELLA SUBMARMOREA (Middendorff, 1846).

1846. *Chiton submarmoreus* MIDDENDORFF, Bull. Phys.-Math., Acad. Sci. Petersburg, vol. 6, No. 8.
 1848. *Chiton submarmoreus* MIDDENDORFF, Mem. Acad. Sci. St. Petersburg, vol. 6, p. 98.
 1886. *Tonicella submarmorea* DALL, Proc. U. S. Nat. Mus., vol. 9, p. 210.
 1892. *Tonicella submarmorea* PILSBRY, Man. Conch. (1), vol. 14, p. 42, pl. 10, figs. 16–24.

Three specimens were taken between tides at Nikolski, Bering Island, June 15, 1906 [S. S. B. 116]. Two of these are entered as Cat. No. 215626, U.S.N.M.

The species has already been recorded from Bering Island by Dall.

Genus SCHIZOPLAX Dall 1879.

SCHIZOPLAX BRANDTII (Middendorff, 1847).

1848. *Chiton Brandtii* MIDDENDORFF, Mem. Acad. Sci. St. Petersburg, vol. 6, p. 128.
 1848. *Chiton Brandtii* MIDDENDORFF, Bull. Phys.-Math., Acad. Sci. St. Petersburg, vol. 6, No. 8, pp. 117–118.
 1879. *Schizoplax Brandtii* DALL, Proc. U. S. Nat. Mus., vol. 1, pp. 2, 296, 328, pl. 1, fig. 8 (dentition).
 1884. *Schizoplax brandtii* DALL, Proc. U. S. Nat. Mus., vol. 7, p. 344.
 1892. *Schizoplax brandtii* PILSBRY, Man. Conch. (1), vol. 14, p. 47, pl. 11, figs. 32–37.

One specimen taken between tides at Nikolski, Bering Island, June 15, 1906 [S. S. B. 117].

The species has already been listed from Bering Island by Dall.

Family ISCHNOCHITONIDAE.

Genus ISCHNOCHITON Gray, 1847.

Subgenus ISCHNORADSIA Shuttleworth, 1853.

ISCHNOCHITON (ISCHNORADSIA) ALBRECHTI (Schrenck, 1863).

Plate 1, figs. 4-5; plate 3, figs. 1-2.

1863. *Chiton Albrechti* SCHRENCK, Bull. Phys.-Math., Acad. Sci. St. Petersburg, vol. 5, p. 511.
1867. *Chiton Albrechti* SCHRENCK, Reisen u. Forsch. Amur-Lande, vol. 2, Zool., p. 283, pl. 13, figs. 7-17.
1892. *Ischnochiton (Ischnoradsia) albrechti* PILSBRY, Man. Conch. (1), vol. 14, p. 147, pl. 19, figs. 70-74.

Material.—This fine chiton is represented in the collection by two large alcoholic specimens [S. S. B. 83], taken at Mororan, Island of Yesso, Japan, July 6, 1906, during one of the shore expeditions. One of these is entered as Cat. No. 215627, U.S.N.M.

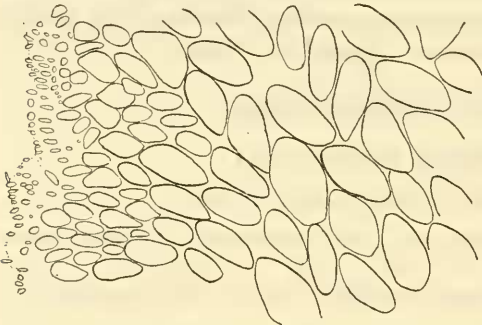


FIG. 1.—ISCHNOCHITON ALBRECHTI [83], PORTION OF GIRDLLE SEEN FROM ABOVE; CAMERA DRAWING FROM A MOUNT IN BALSAM; $\times 28$.

Remarks.—The shell and girdle characters have been well described by Pilsbry, but figures of the radula are now given for the first time (pl. 3, fig. 2). The latter is well developed in this species, the powerful second

laterals being armed with a strong, long, entire cutting edge, and the third laterals having a conspicuous basal process.

Even in the valves of a single individual great variation appears in the number of insertion plates. The specimen dissected shows the following formula: Anterior valve, 17; intermediate valves, respectively, 2-3, 2-2, 1-2, 2-2, 2-3, 2-3; posterior valve, 13 slits.

The branchiae number 47-49 on each side, extending practically the entire length of the foot.

ISCHNOCHITON (ISCHNORADSIA) HAKODADENSIS Carpenter, 1892.

Plate 1, figs. 6-7; plate 3, figs. 3-5; plate 4, figs. 1-3.

1892. *Ischnochiton (Ischnoradsia) hakodadensis* PILSBRY, ex Carpenter MSS., Man. Conch. (1), vol. 14, p. 147, pl. 19, figs. 64-66.
- ?1910. *Ischnochiton hakodadensis* THEILE, Revis. Syst. Chitonen, vol. 2, pp. 111, 112, pl. 8, fig. 44 (dentition).

A medium-sized chiton offering several quite puzzling features was taken rather abundantly by the shore expeditions of the *Albatross* both at Hakodate, Japan, and at Mororan, a port somewhat farther to the north. The specimens exhibit great variability, not only in color, but in the number of radial riblets (from 5 to 11) and marginal slits, but after much study I am unable to do otherwise than refer the

entire series to *I. hakodadensis*. Not only was Carpenter's original material from Hakodate, but a considerable degree of variation similar in character to that remarked upon is recognized in the excellent description by Pilsbry, while furthermore the mounted radulae taken at random from the material before me show very little variation.

Superficially the shell of *I. hakodadensis* is so generally similar to that of *I. albrechti* that I was not prepared for the striking differences to be found in their radulae. Although seemingly a much less powerful affair than the strong radula of *albrechti*, that of the present species is in many respects so much more complicated that I have not yet been able satisfactorily to elucidate all its details, nor can I secure preparations offering a reasonable coincidence with the sketches of two of the teeth given by Thiele. The latter divergence is possibly explicable on the assumption that the specimens which we have independently referred to the same species are not really conspecific. Here the major laterals are strongly bicuspid, with the inner cusp conspicuously the larger and longer, and bear a conspicuous wing-like expansion just below the crown but so narrowly attached at its base and hence so easily broken away that it is not always readily observable in dissected radulae and therefore does not show in most of my camera sketches (pl. 3, figs. 4, 5).

The valves of one of the specimens from Hakodate are slitted as follows: Anterior valve, 19; intermediate valves, respectively, 2-2, 3-3, 2-2, 2-2, 2-3, 2-2; posterior valve, 15 slits; interior bluish or brownish white. A Mororan specimen shows the formula: Anterior valve, 14; intermediate valves, 3-2, 2-3, 3-3, 3-3 (or 4?), 2-2, 2-3; posterior valve, 14 slits; interior deep slate blue.

The beautiful zigzag sculpture of flattened overlapping pointed pustules, which covers the central areas of young specimens, is usually eroded to the pitted appearance characteristic of the adults. It should be added that the girdle scales of my specimens seen *in situ* from above under a relatively high magnification are very weakly striate, not smooth, as described by Pilsbry, though in some of my mounted preparations the striae are almost impossible to distinguish (pl. 1, fig. 7; pl. 3, fig. 3).

The ctenidia number 28-32 on each side.

Material examined.

No. specimens.	Locality.	Collector.	Author's register.	Museum number.
11	Hakodate, Japan..	<i>Albatross</i> , 1906	[85]	Cat. No. 215629, U.S.N.M.
9	Mororan, Japan...do.....	[84]	Cat. No. 215628, U.S.N.M.

Subgenus LEPIDOZONA Pilsbry, 1892.

Primarily because of certain differences observed in the radulae, Thiele removes the *Lepidozona* group of chitons from *Ischnochiton*, and this accomplished finds no recourse except to unite them bodily

with *Callistochiton*. With such a disposition of the group the investigations which I have thus far made do not lead me to concur, even though I can as yet suggest no better arrangement. It would not be surprising if *Lepidozona* should later on require elevation to generic rank, but for the present it is perhaps best to leave it where originally placed by Pilsbry.

ISCHNOCHITON (LEPIDOZONA) AMABILIS, new species.

Plate 3, figs. 6-7; plate 4, figs. 4-7; plate 5; figs. 1-4.

Description.—Animal small, elevated, rather elongate; maximum transverse diameter about three-fifths the length, or of shell alone about two-fifths the length.

Anterior valve rounded, conical; its frontal slope nearly straight, becoming slightly convex on the sides. Interior smooth, marked by about 12 sharp radial lines exactly corresponding to the slits at the margin; teeth slightly roughened at the edge and with rather coarse vertical striations on their outer surfaces (pl. 5, figs. 1-2).

Median valves elevated, beaked very slightly or even scarcely at all, the slopes distinctly convex. Sutural laminae short and broad, the shallow sinus bridged by a short, delicate, slightly concave plate, barely nicked at the margin to form about 8 very delicate squarish teeth; converging striations or lines corresponding in position to the slits continue back through the substance of the shell, the exact number of both slits and lines being often extremely difficult to determine, though the number appears to become considerably less in the more posterior valves. Eaves spongy and quite short (pl. 5, figs. 1-3).

Posterior valve with a rather depressed, yet conspicuous, mucro; posterior region flattened, its slope concave (pl. 5, fig. 4); side slopes convex; sutural plates and intermediate plate similar to those of the middle valves, except that there are only about half as many slits and lines as in the latter. The lines radiating from the mucro to the posterior slits are practically indistinguishable. The hinder margin is thickened and the central region shows a curious, much branched, triangular callus (pl. 5, fig. 2).

Anterior valve with 12, intermediate valves with 1-1, posterior valve with 11 slits.

Entire surface of shell closely and rather heavily granulose. Anterior valve otherwise smooth at the apex, but ornamented below by 33-40 low radial ribs having shallow, not sharply, incised grooves between; some ribs slightly bifurcating or otherwise rendered indistinct, but typically bearing a series of 5 or 6 separate sharply elevated pustules; the last series of pustules (4-8) on each side projecting like teeth from the valve margin. Intermediate valves with lateral areas sculptured like the anterior valve, the 6 or 7 low ribs usually bearing 3-8 pustules each, and the posterior series of 5-6

pustules projecting as dentations past the valve margin; central areas ornamented by some 22 (valve 7) to 26 (valve 4) nodulose ribs, for the most part slightly curved toward the jugum, connected by a series of much fainter and more irregular crossbars, the entire complex becoming reduced to a scarcely regular reticulum over the jugal tract. Posterior valve with central and posterior areas clearly marked, their sculpture closely similar to that of the intermediate valves; posterior area with some 18–24 pustulose radiating ribs, from which the pustules seem very often to be rubbed away (pl. 4, fig. 7).

Girdle wide, averaging about one-fourth the width of the median valves. Dorsal scales translucent, scarcely imbricating, strongly convex, the convexity directed obliquely outward and forward (except in the posterior region), and arranged with a fair degree of definiteness in oblique lines; variable in size, the largest occurring a short distance from the shell, the smallest at the margin; all distinctly ribbed-striate on the upper convexity, the number of striae being generally about 7 to 10 on the larger scales (pl. 4, figs. 5–6). Marginal scales minute, transparent, delicate, spiniform, finely striate, but a few smooth, needle-like spines now and then appearing among them. Ventral scales similar to the marginal, but elongate rectangular, and ranked in closely placed transverse series (pl. 3, fig. 6).

Color of shell in alcohol a warm orange brown, heavily mottled, and variegated with both darker and lighter tints. Girdle with alternate bands of orange brown and tan. Ventral surface a light pinkish tan. Interior of shell grayish pink with lavender clouding.

The radula has strong bidentate major laterals (pl. 3, fig. 7), but its further details have not yet been successfully worked out.

Ctenidia about 28 on each side, extending to a point nearly opposite the middle of the third valve.

Length of entire animal (type-specimen) 21, of shell 19 mm.; width of same 12.25, of shell 7.5 mm.; maximum width of girdle, 2.5 mm.

Type.—Cat. No. 215630, U.S.N.M. [S. S. B. 112].

Type-locality.—Station 4808,¹ 47 fathoms; bottom of sand, shells, and coarse gravel; off Cape Tsiuka, Japan; July 16, 1906 (three specimens).

Remarks.—This very attractive species seems chiefly characterized by the ruddy tones of its prettily maculated color scheme, the very weakly dentate sinus, the bidentate major laterals of the radula, and the small, little crowded, strongly ribbed girdle scales. The sculpturing of the central areas considerably resembles that of the following species, but here the longitudinal riblets are narrower, rougher, and have interspaces distinctly wider than the ribs, differences which are not shown well in the figures. A brief comparison

¹ The station number appearing on the original specimen label is 4708, but this seems clearly erroneous.

with such of the described forms as seem nearest allied is given in the course of our discussion of the next species.

ISCHNOCHITON (LEPIDOZONA) INTERFOSSA, new species.

Plate 3, figs. 8-9; plate 5, figs. 5-8; plate 6, figs. 1-4.

Description.—Animal small, elevated, rather elongate, the sides often nearly straight; maximum diameter about three-fifths the length, or of shell alone less than half the length.

Anterior valve rounded, conical, its slope very slightly convex. Interior smooth, marked by delicate lines radiating toward and in correspondence with the marginal slits; teeth slightly roughened at the edges, their outer surfaces faintly striate (pl. 5, figs. 5-6).

Median valves elevated, beaked, rather sharply carinate, their slopes very slightly convex. Sutural laminae broad; inner margins of same rather abrupt, anterior margins rounded and sloping off more gradually toward the sides; connected across the sinus by a short, delicate, weakly denticulate, concave plate, the minute slits separating the denticles continuing back into the shell as distinct incised lines, the number of these being uniformly 8. Eaves spongy and quite short (pl. 5, figs. 5-7).

Posterior valve with conspicuous mucro situated a little in front of the middle; posterior slope nearly straight (pl. 5, fig. 8). Sutural laminae and intermediate lamina similar to those of the preceding valves, except that there are 9 or 10 of the incised lines. Similar lines radiate from the region of the mucro to the posterior slits. There is a low, semicircular, rounded callus near the margin above the slightly roughened insertion teeth (pl. 5, fig. 6).

Anterior valve with 11, intermediate valves with 1-1, posterior valve with 10 slits.

Entire surface of shell very finely granulose. Anterior valve with immediate apex smooth; elsewhere with from 24-34 low, rounded, radial ribs, separated by shallow but rather sharply cut grooves; the ribs rarely showing a tendency to bifurcation, and typically ornamented with a series of some 6-8 separate, sharply elevated, round pustules, the posterior series on each side containing fewer pustules (4-6) a little larger than the others and projecting like denticles past the margin of the valve. Intermediate valves with lateral areas sculptured like the anterior valve, the 3-4 low ribs intergrooved as above, and bearing 2-3 pustules each, a series of 4-5 larger pustules occurring along the valve margin; central areas ornamented by some 20 (valve 7) to 24 (valve 4) straight or slightly curved, faintly nodulose, longitudinal riblets on each side, these riblets connected by slightly smaller and less regular transverse crossbars in such a manner that in some lights the surface appears reticulate, in others as though cut into lines of small square pits which become more irregu-

lar where the ribs curve over the jugal tract. Posterior valve with posterior and central areas very sharply delimited by a nearly straight line, the sculpture corresponding to that of the intermediate valves; posterior area with about 20–24 radiating pustulose ribs (pl. 6, fig. 2).

Girdle wide, averaging about a quarter the width of the median valves. Dorsal scales translucent, strongly convex, loosely imbricating, their convexities as a rule, except in the posterior region, directed obliquely outward and forward (pl. 6, fig. 4); variable in size, but largest near the shell, becoming exceedingly small at the outer margin, while a few scales larger than their immediate neighbors and of a more opaque whitish color occur scattered with no apparent regularity among the others. Mounted in balsam some of the smaller scales show a faint striation, but the larger appear almost perfectly smooth. Marginal armature comprising quite numerous, very minute, finely striate, conical, transparent spines, with a few scattered needle-like spines among them. Ventral scales minute, rectangular, rod-like, very closely ranked in transverse series (pl. 3, fig. 8).

Color of shell in alcohol a light grayish tan, faintly mottled with cloudings of a ruddier tone. Girdle pale above, with indistinct sutural bands of a darker shade. Entire ventral surface of animal and girdle a light pinkish tan. Interior of shell creamy, shading to warm tones of pink and salmon in the deeper regions.

Radula with strong, unicuspid major laterals, winged minor laterals, and well developed, fan-shaped rhachidian teeth (pl. 3, fig. 9).

Ctenidia about 28 on each side, extending forward to the second valve.

Length of entire animal (type-specimen) 21, of shell, 18.5 mm.; width of same 12.5, of shell 8 mm.; maximum width of girdle, 2.5 mm.

Type.—Cat. No. 215631, U.S.N.M. [S. S. B. 115].

Type-locality.—Station 4808,¹ 47 fathoms; bottom of sand, shells, and coarse gravel; off Cape Tsiuka, Japan; July 16, 1906 (three specimens).

Remarks.—*I. interfossa* is a very neat appearing little species and apparently a typical *Lepidozona*. Though much resembling the preceding species in form and sculpture, the color alone is sufficient for preliminary separation of the specimens, while a more minute examination reveals numerous differences. The special features are the large, smooth, whitish dorsal scales of the girdle; sharply angled jugum; beaked valves; sharply-cut grooves between the ribs of the anterior valve and lateral areas; the number of these ribs; and the very regular, basket-like sculpturing of the central areas, the longitudinal riblets being distinctly wider than the intervening spaces.

Of allied species *I. cultratus* Carpenter, according to Pilsbry's description, differs from both *I. amabilis* and *I. interfossa* in having

¹ These specimens were originally in the same vial as those of *I. amabilis*, so that here also the station number on the label requires correction.

but 4 ribs (separated by rather acute interstices, as in *interfossa*) on the lateral areas, 13 on the anterior valve, and but 16 narrow riblets on the central areas, the latter connected by irregular wrinkles rather than transverse bars. The anterior valve has only 8 slits, and the convex, *nondentate* sinus of the remaining valves is also distinctive if correctly observed. The dorsal girdle scales are said to be weakly striate.

I. craticulatus (Gould) differs from both the *Albatross* species in the far more numerous riblets of the lateral areas ("8-10"), and of the anterior valve ("about 50"), the minute latticing of the central areas, and the fact that the teeth of the head valve are said to be "distinctly notched or nicked at the edges and deeply, coarsely grooved outside." The girdle scales are described as striate.

I. coreanicus (Adams and Reeve) is insufficiently known and hence not liable to comparison with the above species in any certain fashion at the present time, though Pilsbry¹ has suggested a possible identity with *I. craticulatus*.

The only other *Lepidozonia* which I can find to have been recorded from this region is *I. mertensii* (Middendorff), a much more coarsely sculptured species, with which none of the *Albatross* forms are likely to be confounded.

ISCHNOCHITON (LEPIDOZONA) PILSBRYANUS, new species.

Plate 6, figs. 5-9; plate 7.

Description.—Animal small, elevated, the sides only slightly convex; maximum transverse diameter a little less than half the length, or of shell alone about three-sevenths the length.

Anterior valve rounded, conical, its slope straight in front, becoming slightly convex on the sides (pl. 7, fig. 1). Interior smooth, marked with a series of about 13 delicate radiating lines corresponding to the marginal slits; teeth beveled, slightly rugose at the edges and obscurely and irregularly striate outside (pl. 7, fig. 2).

Median valves elevated, not beaked, high arched, sharply angled at the jugum, the side slopes nearly straight or very slightly convex. Sutural laminae short and broad; connected across the sinus by a delicate, scarcely projecting, very weakly dentate plate, the outline of the latter varying from strongly convex in the second valve to slightly concave in the more central valves, and showing apparently but about 8 slits, though there are some 10-12 of the incised lines which ordinarily correspond. Eaves short, relatively solid (pl. 7, figs. 1-4).

Posterior valve with mucro nearly median; posterior slope strongly concave; sutural laminae as described above, the minute slits and lines each about 8 in number; similar lines radiate from the mucro

¹ *Man. Conch.*, vol. 15, p. 85.

region to the posterior slits, the concavity of the mucro forming the base of a low V-shaped callus extending forward; insertion teeth irregularly roughened at margin (pl. 7, figs 2, 5).

Anterior valve of paratype with 13 slits; intermediate valves with 2-2, 1-1, 1-1, 1-2, 2-2, 2-2 slits; posterior valve with 13 slits.

Entire surface of shell rather closely, heavily granulose. Anterior valve ornamented with many narrow radiating ribs, their total number about 55 at the margin, but becoming fewer and finally almost obsolete toward the apex, said ribs for the most part broken into a close set series of perhaps 20 low, distinct, rounded pustules, the latter often somewhat worn, and the posterior series larger and fewer (about 12) but so nearly obsolete as barely to dentate the margin; interspaces shallow and ungrooved. Intermediate valves with lateral areas slightly elevated and sculptured as above, the pustulose ribs 5-7 in number, and with a series of some 7-10 larger, but more obsolete, pustules bordering the posterior margin; central areas with 20 (valve 7) to 26 (valve 4) pustulose riblets on each side, usually a little narrower than their interspaces, the pustules small but distinct and coinciding with the lines of growth so as to appear grouped in squares, though usually the transverse connecting ridges are very faint if present at all; both ribs and pustules obsolete over the jugal tract. Posterior valve with posterior and central areas sharply delimited, the mucro forming an obtuse angle in their boundary; sculpture as above, the posterior area with 30-35 radiating pustulose ribs similar to those of the lateral areas (pl. 6, fig. 7).

Girdle wide, averaging about one-fourth the width of the median valves. Dorsal scales translucent, rather small, crowded, closely imbricate (pl. 6, fig. 8), their convex surfaces very finely ribbed-striate, the numerous (12-18) riblets being so delicate that the scales appear smooth under low magnifications (pl. 6, fig. 9; pl. 7, fig. 6). Marginal scales small, partly needle-like, partly robust spiniform, the latter finely striate (pl. 7, fig. 6).

Color of shell in alcohol a light tan with scattered dark red-brown spots on the central areas and more numerous along the jugum, where they blend to form conspicuous triangular maculations. Girdle tan above, but darker and duller in tone than the groundwork of the shell and very indistinctly mottled with brown. Ventral surface of animal and girdle a light tan. Interior of shell a pale flesh color, some of the valves showing a narrow brownish ray on each side of the jugum.

The radula has strongly bicuspid major laterals, minutely winged minor laterals, and fan-shaped rhachidian teeth (pl. 7, fig. 7).

Ctenidia about 30 on each side, extending forward to the second valve.

Length of entire animal (type-specimen) 24, of shell 22 mm.; width of same 13, of shell 9 mm.; maximum width of girdle, 2.7 mm.

Type.—Cat. No. 215632, U.S.N.M. [S. S. B. 118].

Type-locality.—Station 4810; 195 fathoms; bottom of fine gray sand; bottom temperature 44.7° F.; off Cape Sirakami, Japan; July 16, 1906 (two specimens).

Remarks.—This handsome species is well characterized, the only one apparently requiring comparison with it being the *I. craticulatus* of Gould, but the latter is a more heavily granulose species and should be, according to the figures given by Pilsbry in his Manual, quite easy to distinguish. The special features of *I. pilsbryanus* seem to be in brief as follows:

1, the pale, tawny coloration.

2, the sharply arched, elevated shell.

3, the sculpture of numerous finely granulose riblets prevailing nearly all over the shell, and the arrangement of the pustules in squares without interlaticing on the central areas.

4, the reduplication of teeth and slits in many of the intermediate valves.

5, the numerous insertion slits (13) in each of the terminal valves.

6, the crowded, closely imbricating, very finely ribbed-striate dorsal scales.

The dedication of this species to Dr. Henry A. Pilsbry will require no apology to students of the group.

Family MOPALIIDAE.

Genus **PLACIPHORELLA** Carpenter, 1878.

PLACIPHORELLA STIMPSONI (Gould, 1859).

Plate 8, figs. 1-2; plate 9.

1859. *Chiton (Molpalia) stimpsoni* GOULD, Proc. Bost. Soc. Nat. Hist., vol. 7, p. 161.

1860. *Chiton (Molpalia) stimpsoni* GOULD, Otia Conch., p. 118, [fide Dall].

1886. *Placiphorella stimpsoni* DALL (part), Proc. U. S. Nat. Mus., vol. 9, p. 210.

1892. *Placiphorella stimpsonii* PILSBRY, Man. Conch. (1), vol. 14, p. 307, pl. 62, figs. 84-87.

Material.—The *Albatross* expedition took two specimens of this species between tides at Hakodate, Japan [S. S. B. 93].

Remarks.—I can add little to the excellent description given of the apparently somewhat variable shell characters by Pilsbry, but the preservation of the specimens in alcohol renders possible a few additional observations on the girdle. There is a series of large bristles near the middle of the girdle, one opposite each suture, and five or six continuing around the head valve. Other series of large bristles adorn the anterior lobe, more especially near the margin, in

addition to a number of smaller and less definitely arranged bristles and tufts of spines. The figure of one of the large bristles by Carpenter, which appears in the Manual (vol. 14, pl. 62, fig. 86) is very misleading, and I can only surmise that he must have mistaken the white or light-colored bands of spines, revealed by these specimens under a sufficiently high magnification, for spineless areas. When perfect the light and dark brown bands in alternation are a conspicuous feature of the bristles. An attempt is made to convey some idea of this in the accompanying drawing (pl. 9, fig. 4). Here it also appears that the spinose armature of all the larger bristles is exceedingly heavy, the spines being crowded upon one another in a fashion not conspicuously different from that observable in *P. velata* Carpenter. These two species are indeed exceedingly close and resemble one another much more nearly than either patterns the various Alaska-Bering Sea forms, with which they have at times been confounded.

In addition to those mentioned by Pilsbry, the following differences from California specimens of *P. velata* may be noted:

- 1, the shorter, wider valves.
- 2, the flatter outline.
- 3, the conspicuously marbled slate and buff coloration.

Outline drawings of the valves (pl. 9, figs. 1-3) and the typically Mopalioid radula (pl. 9, figs. 7-8) are here given, the latter for the first time.

The ctenidia number about 26 on each side.

PLACIPHORELLA BOREALIS Pilsbry, 1892.

Plate 8, figs. 3-5; plate 10.

1886. *Placiphorella stimpsoni* DALL (part), Proc. U. S. Nat. Mus., vol. 9, p. 210.

1892. *Placiphorella borealis* PILSBRY, Man. Conch. (1), vol. 14, p. 309, pl. 66, figs. 14-17.

Material.—Station 4803; 228 fathoms; bottom of black sand and gravel; bottom temperature 35.4° F.; off Cape Rollin, Simushir Island, Kuril Group; June 24, 1906 (seven specimens) [S. S. B. 94]. Four specimens are entered as Cat. No. 215633, U.S.N.M.

Remarks.—The shell of this species is the subject of a careful and detailed description by Pilsbry, but as the girdle characters have hitherto remained unknown it seems worth while to describe them in some detail. The dorsal surface of the entire girdle is covered with very minute pointed spinelets, rather heavily distributed. Among these one occasionally finds scattered spines or groups of spines slightly larger in size, a condition more evident near the margin than elsewhere. In addition occur the usual armored bristles characteristic of the genus, the most conspicuous being a fairly regular series bordering the entire anterior lobe a short dis-

tance within the margin, but inside of these only a few scattered bristles are evident, and taken as a whole the girdle is remarkably free of them. Most of them are quite broken away in my material, but a series of the stumps or "pores" can be made out running clear around the girdle, most of them corresponding to the sutures in position, though there are at least 6 or 7 behind the tail valve, and 2 in the same series on either side of the head valve. The extreme margin of the anterior lobe is decorated with a single series of short, very spinose bristles, between and beneath which occur a row of spines springing directly from the substance of the girdle itself (pl. 8, fig. 5). Toward the front of the lobe the spinose bristles are quite close together, but, although continued around the entire lobe, they become progressively smaller and more infrequent toward the sides and rear. The anterior margin frequently, if not always, exhibits a microscopic crenulation corresponding roughly to the bristles so that from certain aspects the latter appear as though borne upon small lobes. The contrast between the two types of bristles (i. e., marginal and dorsal) is very marked. The marginal bristles (pl. 10, fig. 6) have a bushy appearance, due to the very numerous spines, which, though not actually curved, often appear so because of the angle at which they project from the more or less twisted core. The dorsal bristles (pl. 10, fig. 4) are very narrow, trim, and slender, but larger, their long straight spinelets being much less crowded and closely applied to the core of the bristle for practically their entire length. Their arrangement is throughout very neat and regular. A cross section shows only about 8 spines to the tier on this type of bristle. The bristles do not appear to be banded, but are nearly uniform in color.

The radula (pl. 10, fig. 9) is of the same type as that of *P. stimpsoni* and *P. velata*, but the teeth show numerous differences in detail.

The ctenidia number 22-24 on each side.

The species has not been reported since its foundation by Pilsbry upon the valves of a single specimen obtained by Grebnitzki at Bering Island. The present record, therefore, constitutes a very appreciable extension of the known range. Despite his inadequate material, Pilsbry succeeded in acutely discriminating all the more important shell characters. *P. borealis* is, in fact, a very distinct species, and in the radiate sculpture of the anterior valve, complete sinus, and peculiar bristles, possesses features sufficient effectually to prevent confusion with any of the other described species, unless we consider the *Placophoropsis* group, the members of which are well separated by their subgeneric characters.

From *P. velata* and *P. stimpsoni* the more sparsely hairy girdle and much weaker armature of the bristles are striking differences.

Family CHITONIDAE.

Genus CHITON Linnaeus, 1758.

CHITON, species.

Plate 8, fig. 6.

A small specimen collected between tides at Aikawa, Rikuzen [S. S. B. 120], Cat. No. 215634, U.S.N.M., can not be identified with any of the described Japanese Chitonidae. It is quite likely new, and the accompanying illustration was prepared in the expectation of so treating it. Unfortunately the specimen seems at one time to have suffered immersion in formalin or some other decalcifying medium. At any rate, the valves proved so soft and subject to disintegration upon removal that their characters could not be made out with enough accuracy to justify naming the specimen. When the species is later rediscovered it may perhaps be recognized by the figure.

EXPLANATION OF PLATES.

PLATE 1.

- FIG. 1. *Leptochiton diomedae* Berry [95], dorsal aspect of first, third, and last valves of type specimen; $\times 8$.
2. *Leptochiton diomedae* Berry [95], entire animal in ventral aspect; $\times 3$.
3. *Leptochiton diomedae* Berry, dorsal view of portion of girdle of same specimen; drawn from a mount in balsam; $\times 28$.
4. *Ischnochiton (Ischnoradsia) albrechti* Schrenck [83], dorsal view of portion of girdle; drawn from a mount in balsam; $\times 7\frac{1}{2}$.
5. *Ischnochiton (Ischnoradsia) albrechti* Schrenck, a few scales from the same preparation as fig. 4 seen in greater magnification; $\times 27$.
6. *Ischnochiton (Ischnoradsia) hakodadensis* Carpenter [85], dorsal view of portion of girdle of a specimen from Hakodate; drawn from a mount in balsam; $\times 10$.
7. *Ischnochiton (Ischnoradsia) hakodadensis* Carpenter, a few scales from the same preparation as fig. 6 seen in greater magnification; $\times 27$.

PLATE 2.

- FIG. 1. *Leptochiton diomedae* Berry [95], exterior view of first, third, and last valves of type; camera drawing; $\times 9$.
2. Interior view of same, same scale.
3. Anterior view of third valve; same scale.
4. Isolated girdle scales from same specimen, the four larger from the dorsal, the four smaller from the ventral surface of the girdle; camera drawing from a mount in balsam; $\times 163$.
5. Portion of girdle margin of same specimen, seen from above; camera outline from a mount in balsam; same scale as preceding.
6. Teeth from radula of same specimen; camera drawing from a mount in balsam; $\times 163$.

PLATE 3.

- FIG. 1. *Ischnochiton* (*Ischnoradsia*) *albrechti* Schrenck [83], isolated girdle scales drawn by camera from a mount in balsam; the largest scale shows radial striae, the others transverse color bands; $\times 31$.
2. Isolated radula teeth from same specimen; camera drawing from a mount in balsam; $\times 31$.
3. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [84], isolated girdle scales of a specimen from Mororan; camera drawing from a mount in balsam; $\times 31$.
4. Isolated radula teeth from same specimen; camera drawing from a mount in balsam; $\times 66$.
5. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [85], isolated radula teeth of a specimen from Hakodate; camera drawing from a mount in balsam; $\times 66$.
6. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [113], isolated girdle scales of paratype; camera drawing from a mount in balsam; $\times 31$.
7. Two major lateral teeth from radula of same specimen, camera drawing from a mount in balsam; $\times 66$.
8. *Ischnochiton* (*Lepidozona*) *interfossa* Berry [114], isolated girdle scales of paratype; camera drawing from a mount in balsam; $\times 31$.
9. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; $\times 66$.

PLATE 4.

- FIG. 1. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [85], dorsal aspect of a specimen from Hakodate; $\times 1\frac{1}{2}$.
2. Ventral aspect of same specimen; same scale.
3. Dorsal aspect of fourth valve of another specimen from the same lot; $\times 4$.
4. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [112], dorsal aspect of type; $\times 2$.
5. Dorsal aspect of a portion of girdle of paratype [113]; camera drawing from a mount in balsam; $\times 11$.
6. Portion of same preparation under greater magnification; $\times 50$.
7. Dorsal aspect of first, fifth, and last valves of paratype [113]; $\times 6\frac{2}{3}$.

PLATE 5.

- FIG. 1. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [113], exterior view of first, fifth, and last valves of paratype; camera drawing; $\times 6\frac{1}{2}$.
2. Interior view of same; same scale.
3. Anterior view of fifth valve; same scale.
4. Profile of last valve; same scale.
5. *Ischnochiton* (*Lepidozona*) *interfossa* Berry [114], exterior view of first, fifth, and last valves of paratype; camera drawing; $\times 6$.
6. Interior view of same; same scale.
7. Anterior view of fifth valve; same scale.
8. Profile of last valve; same scale.

PLATE 6.

- FIG. 1. *Ischnochiton (Lepidozona) interfossa* Berry [115], dorsal aspect of type; $\times 2$.
 2. *Ischnochiton (Lepidozona) interfossa* Berry [114], dorsal aspect of first, fifth, and last valves of paratype; $\times 6$.
 3. Dorsal aspect of portion of girdle of same specimen; drawn from a mount in balsam; $\times 12$.
 4. Portion of same preparation under greater magnification; $\times 43$. On the immediate area selected for illustration the scales are less crowded than is typically the case.
 5. *Ischnochiton (Lepidozona) pilsbryanus* Berry [118], dorsal aspect of type; $\times 1\frac{1}{2}$.
 6. Ventral aspect of same; same scale.
 7. *Ischnochiton (Lepidozona) pilsbryanus* Berry [119], dorsal aspect of first, third, and last valves of paratype; $\times 4.8$.
 8. Dorsal aspect of portion of girdle of same specimen; drawn from a mount in balsam; $\times 9\frac{1}{2}$.
 9. Portion of same preparation under greater magnification; $\times 27$. The scales are typically much more crowded than appears in the drawing.

PLATE 7.

- FIG. 1. *Ischnochiton (Lepidozona) pilsbryanus* Berry [119], exterior view of first, third, and last valves of paratype; part camera drawing; $\times 7$.
 2. Interior view of same; same scale.
 3. Anterior view of third valve; same scale.
 4. Interior view of left side of second valve; same scale.
 5. Lateral view of tail valve; same scale.
 6. Isolated girdle scales from same specimen; camera drawing from a mount in balsam; $\times 25$.
 7. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; $\times 52$.

PLATE 8.

- FIG. 1. *Placiphorella stimpsoni* (Gould) [93], dorsal aspect of a specimen from Hakodate; slightly magnified.
 2. Ventral aspect of same; same scale.
 3. *Placiphorella borealis* Pilsbry [94], dorsal aspect of a specimen from 228 fathoms, off Simushir Island; same scale.
 4. Ventral aspect of same; same scale.
 5. Portion of margin of anterior lobe of girdle of another specimen from the same lot; viewed ventrally from a preparation in balsam; $\times 18$.
 6. *Chiton* species [120], dorsal aspect of a specimen from Aikawa; $\times 2.4$.

PLATE 9.

- FIG. 1. *Placiphorella stimpsoni* (Gould) [93], exterior view of first, fourth, and last valves; camera drawing; $\times 2\frac{1}{2}$.
 2. Interior view of same; same scale.
 3. Posterior view of sixth valve; same scale.
 4. Basal portion of large spinose bristle from anterior lobe of girdle of same specimen; camera outline from a mount in balsam; $\times 65$.
 5. Isolated spine from large bristle; camera drawing; $\times 65$.
 6. Portion of margin of girdle near front of anterior lobe of same specimen; camera drawing from a mount in balsam; $\times 65$.
 7. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; $\times 65$.
 8. Series of teeth from one side of radula of same specimen; same scale as fig. 7.

PLATE 10.

- FIG. 1. *Placiphorella borealis* Pilsbry [94], exterior view of first, third, and last valves; camera drawing; $\times 2\frac{1}{4}$.
2. Interior view of same; same scale.
3. Posterior view of fifth valve; same scale.
4. Basal portion of large spinose bristle from anterior lobe of girdle of same specimen; camera outline from a mount in balsam; $\times 60$. On most bristles the spines appear to be more closely placed than is indicated in the drawing.
5. Portion of ventral surface of anterior lobe of same specimen, showing patches of spinelets; camera drawing from a mount in balsam; $\times 60$.
6. Basal portion of marginal spinose bristle from anterior lobe of girdle of same specimen; camera drawing from a mount in balsam; $\times 60$.
7. Isolated spines from ventral surface of anterior lobe of same specimen; camera drawing from a mount in balsam; $\times 150$.
8. Isolated girdle and bristle spines from same specimen; camera drawing from a mount in balsam; $\times 150$.
9. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; $\times 60$.

NOTE.—The drawings on Plates 1, 4, 6, and 8 are from the brush of Mr. E. Russel Lord-Wood.

The majority of the figures as originally prepared were intended for plates of a larger size than those used in these Proceedings. Then again the plates first made were destroyed by fire and the make-up of several of them subsequently rearranged. This resulted in changes in the degree of magnification of the figures at a time when most of the specimens were no longer available for checking. There is therefore an unavoidable source of possible error in the magnifications as given.